Satellite-based Global Lightning and Severe Storm Monitoring Using VHF Receivers

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FORTE Science/Operations Team
V-Sensor Development Team

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VHF vs. Optical Lightning Detection

	OPTICAL	**VHF**
Detects:	Light (current)	VHF (changes in current)
Geolocation Technique / Min. # of satellites:	CCD array/ 1	Time-of-arrival (TOA)/ 3
Atmospheric Effects:	Scattering/ attenuation	none
Ionospheric Effects:	none	Frequency-dependent dispersion (can be mitigated)
Lightning Taxonomy:	Cannot distinguish	Can distinguish CG vs. IC, return strokes, leaders, TIPPs, etc.

FORTE: Fast On-Orbit Recording of Transient Events
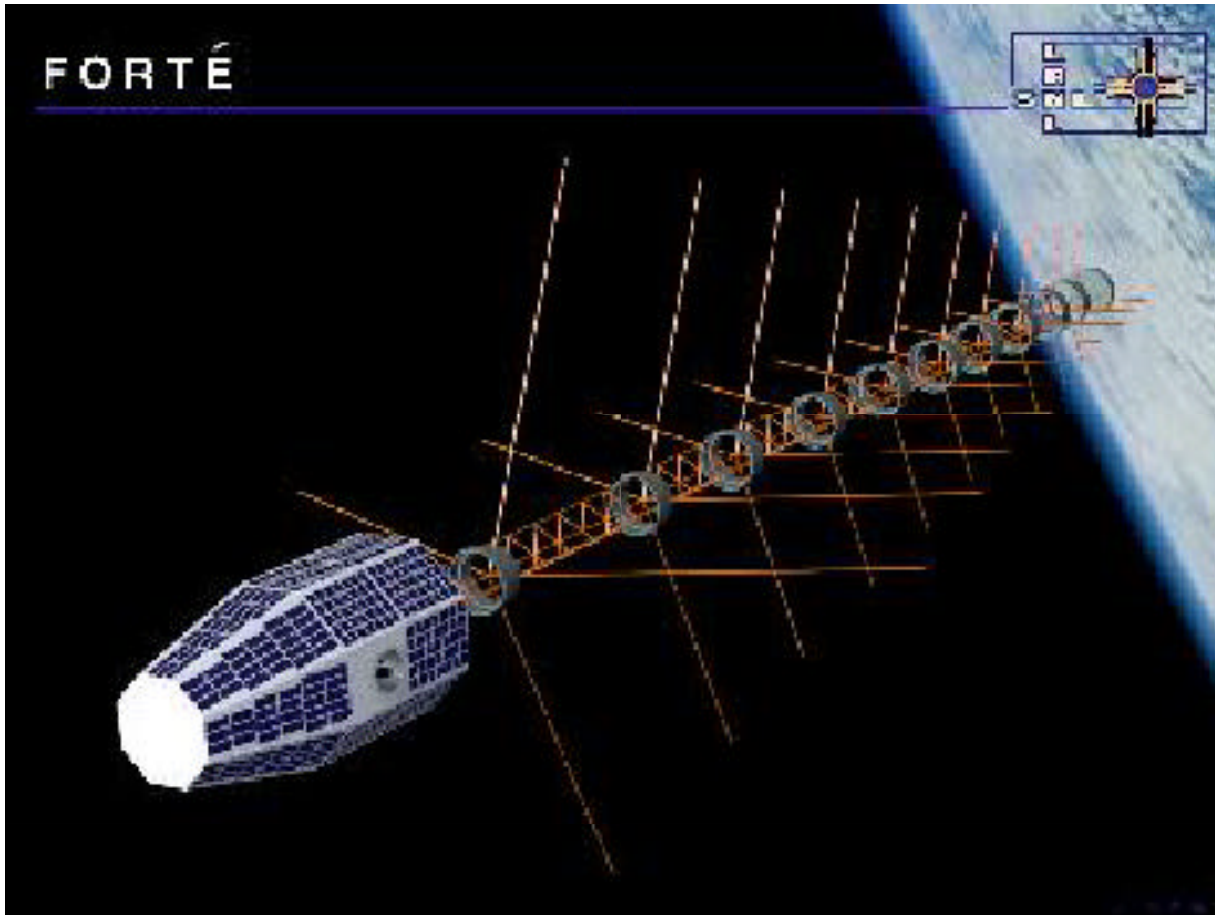
MISSION
- Testbed for Next Generation Nuclear EMP Sensor Technology.
- Space-based Lightning Detection.

PLATFORM
Altitude: ~ 825 km
Inclination: 70 degrees
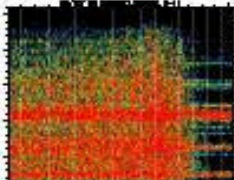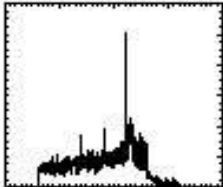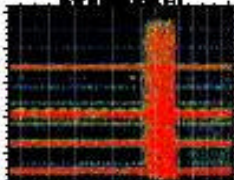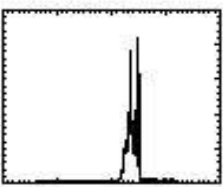Launched: August 29, 1997
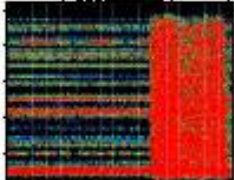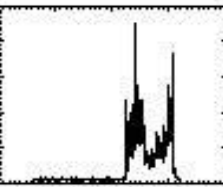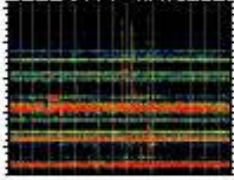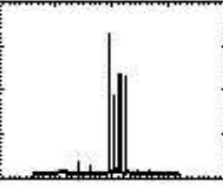
SENSORS
Type: Broadband VHF receivers
              - (26 – 300 MHz)
              - 1 µs or better resolution

              Photodiode (PDD)
              -15 µS resolution

              CCD Imager (LLS)
              -10 km location accuracy

Data: Optical/VHF Waveforms
              Event times
              Event location

Automated Lightning Classification

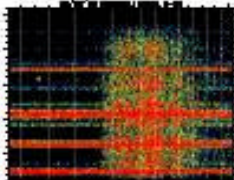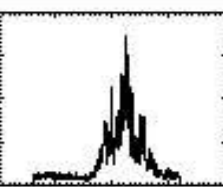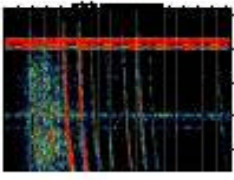| Spectrogram	Power profile	Taxonomy	Features
		1st -RS w/ stepped leader	width > 400 μS, steady increase, impulse at attachment
		Subseq. -RS w/ dart leader	10μS < wid. < 500 μS sharp fall, impulse at attachment
		1st +RS	10μS < wid. < 500 μS sharp rise, impulse at attachment
		Impulsive in-cloud events, including TIPPS	1 μS < width < 10 μS strong
		Non-impulsive in-cloud events including K-events	10 μS < wid. < 500 μS slow rise/fall
		Mixed impulsive and non-impulsive in-cloud events	Mixed of impulsive and non-impulsive features

/r/projects/sea/dtfcric/19980515.crc 9:52 40.018 - 20:31:18.509 284 +/-0.0ms conics
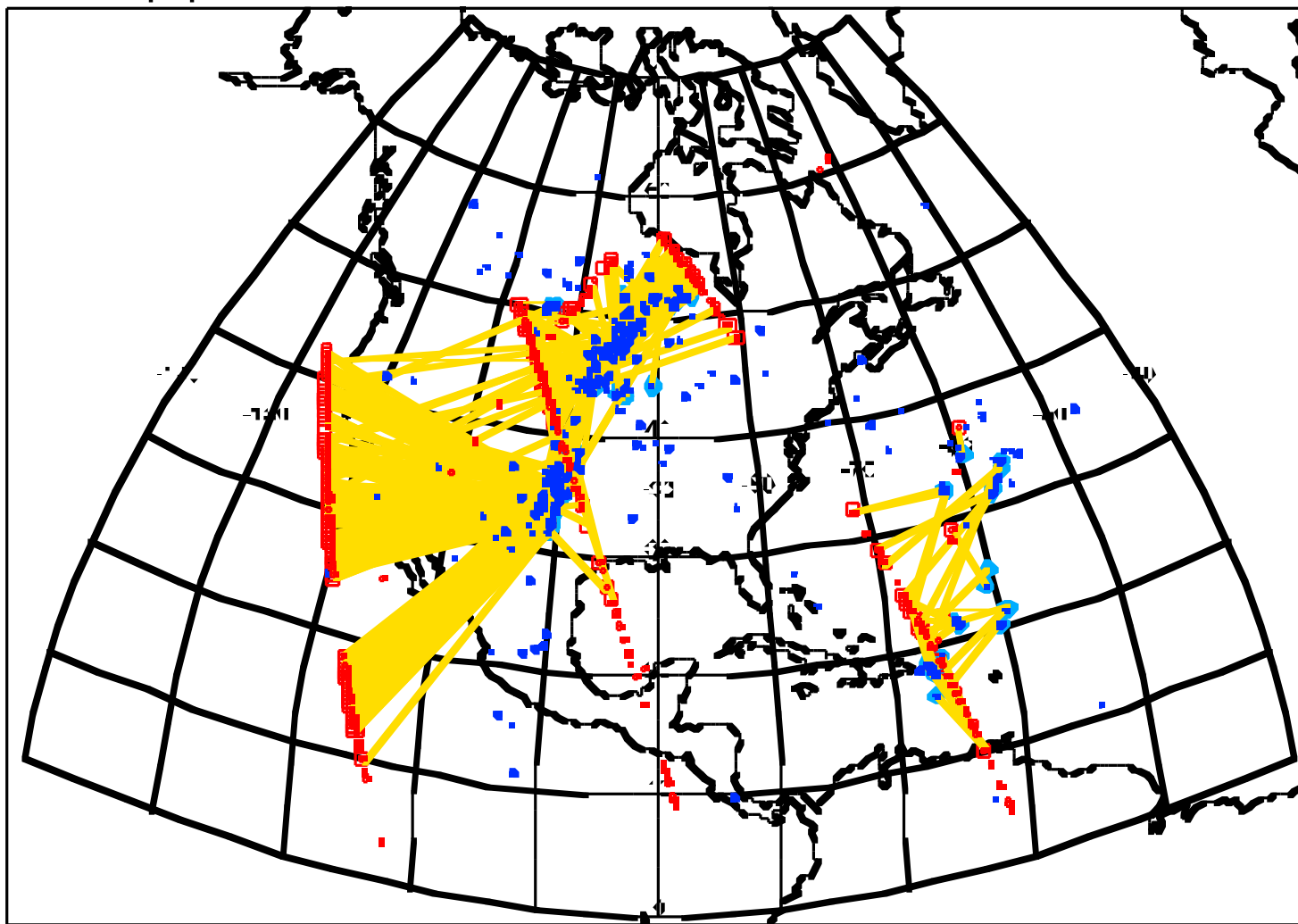
Utility of a Global Lightning Monitor

1.) Severe Storm forecasting/warning
- improve severe storm identification/tracking (especially over regions
  lacking sufficient ground radar coverage, e.g. oceans)
- improve NWS severe storm warning capability
  - flash rate related to updraft velocity, cloud-top height,
    stage of storm development, general cloud structure
- improve forest fire prediction capability

2.) Aviation
- support military operations
- increase safety/efficiency of commercial air travel via flight path optimization

3.) Global Electrical Circuit
- quantify lightning contribution

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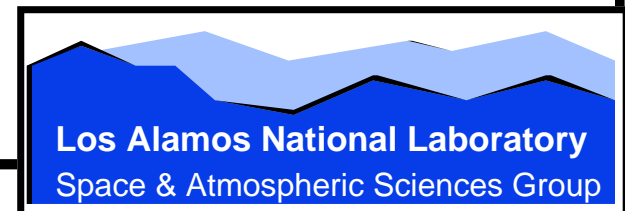
Utility of a Global Lightning Monitor

4.) Global climatology/meteorology

- Lightning as a proxy for:
  - quantifying deep convective processes
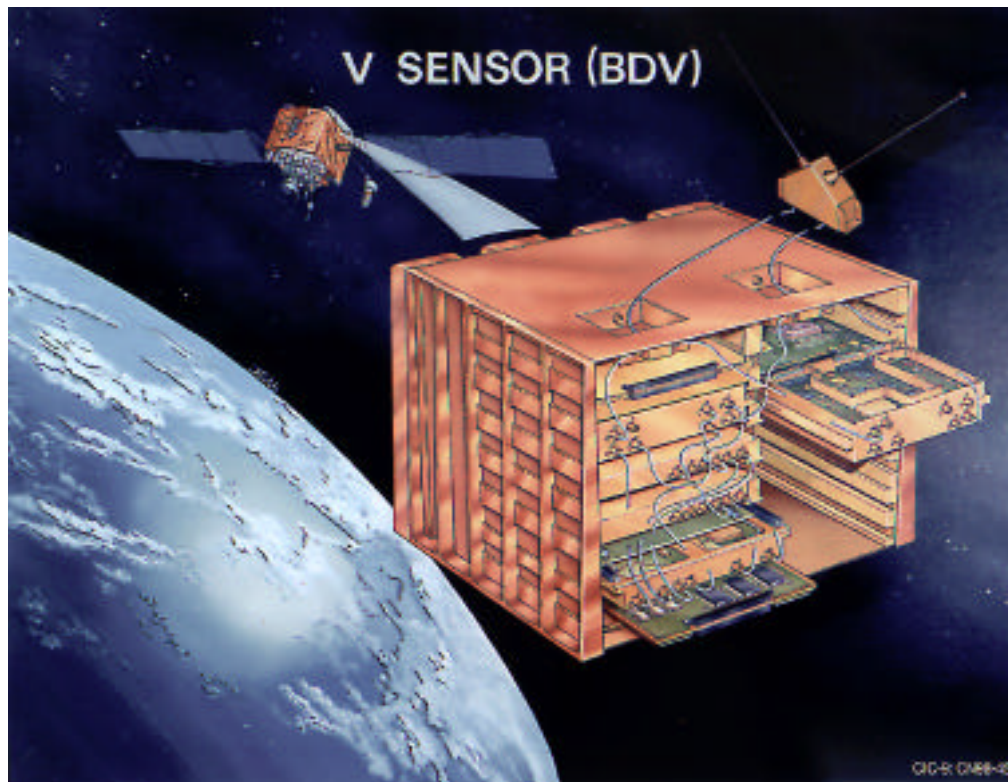 - quantifying global rainfall rates for certain types of storms

- use above as input into General Circulation Models (GCMs)
- global lightning occurrence as an indicator of global/regional climate change (e.g. ENSO)
- NO_x production

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GPS Block IIF: V-Sensor (BDV)

V SENSOR (BDV)

MISSION
Space-based EMP monitoring of nuclear detonations for treaty verification

PLATFORM
Platform: GPS Constellation
(24 Block IIF satellites)
Altitude: 20,000 km
Launches: 2005-2010

SENSORS
Type: Broadband VHF receivers
(low/mid VHF)
Data: Waveforms
Event time
Event location

NAP/S2 DOWNLINK
Data Rate: dump once/day/satellite
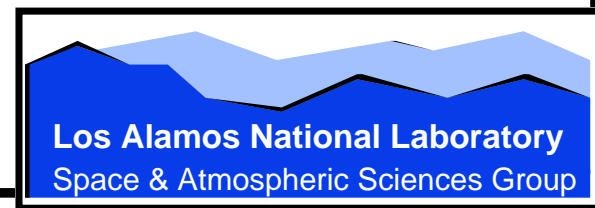Gnd. stations: 1*
Onboard memory: 4 MB
Net events/day/sat ~1000

*Possibility of more gnd stations
(i.e. more events/day/sat)

VHF Global Lightning and Severe Storm Monitor (V-GLASS)

Platform: 24 GPS satellites @ 20,000 km altitude

Phenomenology: Low/mid VHF

Ground Stations: 2 – 3

Reportable Event Rate: ~ 10 /sec/satellite (working to increase)

Data products: Geolocation with excellent resolution
                                            Event time
                                            Some waveforms
                                            On-board lightning-type ID (future?)

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V-GLASS Status

- First draft of Concept Definition completed

- Integrating V-GLASS event capture/reporting algorithm into V-Sensor design

- Trying to develop community advocacy/ identify funding for a formal program

   - additional ground stations
   - develop data products/distribution network

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